"DEVELOPMENTS IN THE AUTOMATION AND REMOTE OPERATION OF LOCKS AND BRIDGES"

FINAL REPORT
INCOM WORKING GROUP 96, 2008

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US Army Corps of Engineers

Engineer Research & Development Center

FINAL REPORT
INCOM WORKING GROUP 28/96, 2008

"DEVELOPMENTS IN THE AUTOMATION AND REMOTE OPERATION OF LOCKS AND BRIDGES"

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PIANC WG28

Terms of Reference

"The aim is to organise an exchange of international experience and learning about:
1) automation of river works (dams, locks, mobile bridges…)
2) remote control of these facilities."

Study Areas

Previous Reports, especially WG18
Developments since WG18 report was completed by re-issuing their questionnaire.

Advances in:
- Automation Equipment
- Communications
- CCTV
- Health & Safety
- Legislation
- Commercial Pressures

TABLE OF CONTENTS (72 Pages)

- Lock Automation: State of the Art in Europe and the United States
- Instrumentation and Control
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  - Appendix A: Responses to Questionnaire
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PLC Based System

INPUTS

Pushbuttons

Limit Switches

Level Sensors

Graphical User Interface (GUI)

Programmable Logic Controller (PLC)

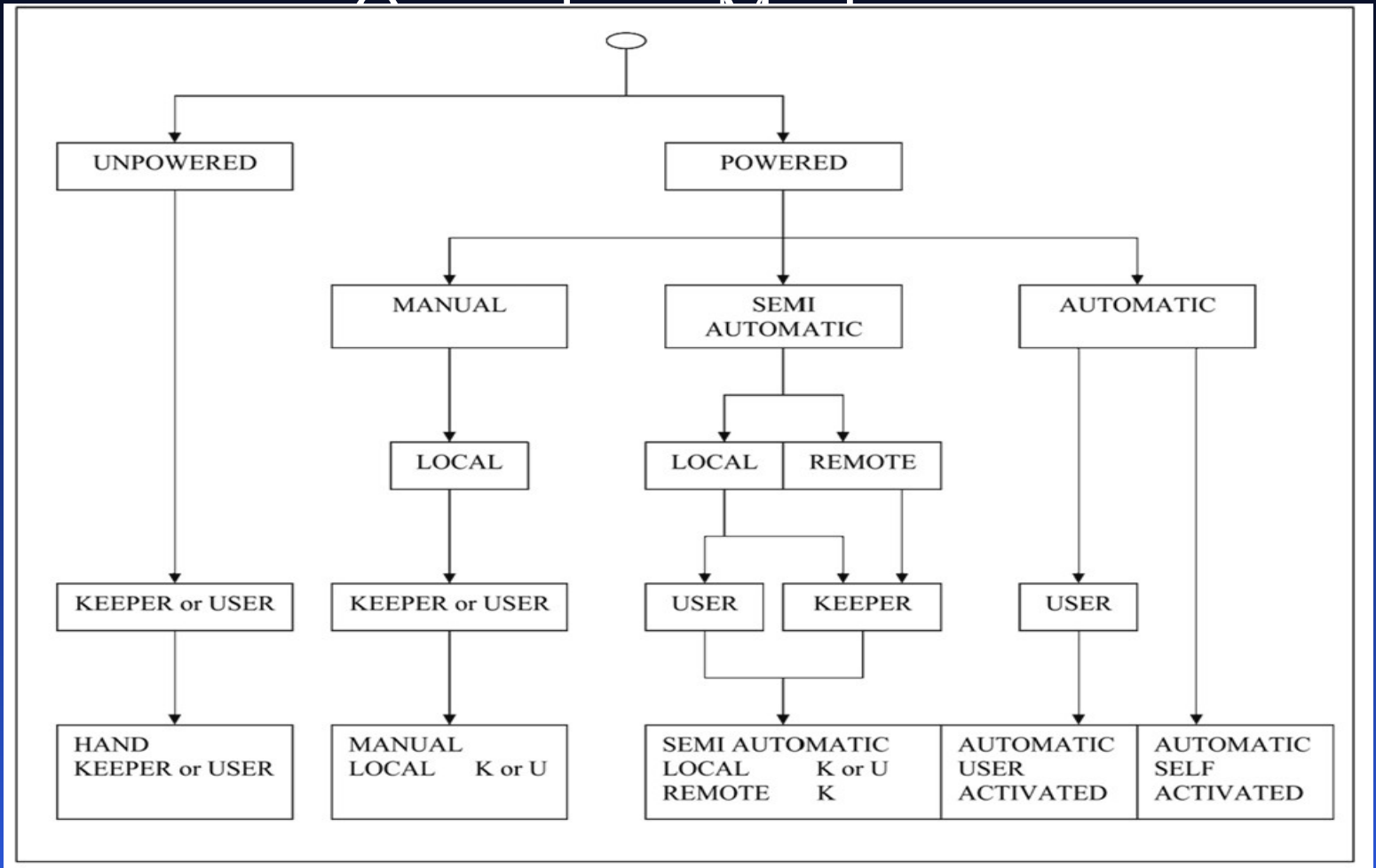
OUTPUTS

Motors

Solenoids

Warning Horns

Flow Diagram for Lock Operation Modes



Summary of European Lock and Bridge Operations

	LOCKS				BRIDGES			
	Mainly commercial (>70%)	Mixed	Mainly leisure(>70 %)	TOTAL	Mainly commercial (>70%)	Mixed	Mainly leisure(>70 %)	TOTAL
UNPOWERED - HAND OPERATED - **USER**			3389	3389			93	93
UNPOWERED - HAND OPERATED - KEEPER		121	688	809	1		21	22
LOCAL - MANUALLY OPERATED **- USER**	6		47	53	2	1	4	7
LOCAL - MANUALLY OPERATED - KEEPER	96	34	276	406	4	8	23	35
LOCAL - SEMI-AUTOMATIC OPERATION **- USER**			128	128			150	150
LOCAL - SEMI-AUTOMATIC OPERATION - KEEPER	190	117	138	445	238	484	393	1115
REMOTE - SEMI-AUTOMATIC OPERATION - KEEPER	49	23	43	115	102	84	20	206
AUTOMATIC OPERATION - ACTIVE	58	308	346	712	5	17	54	76
AUTOMATIC OPERATION - **PASSIVE**							6	6
TOTAL	399	603	5055	6057	352	594	764	1710

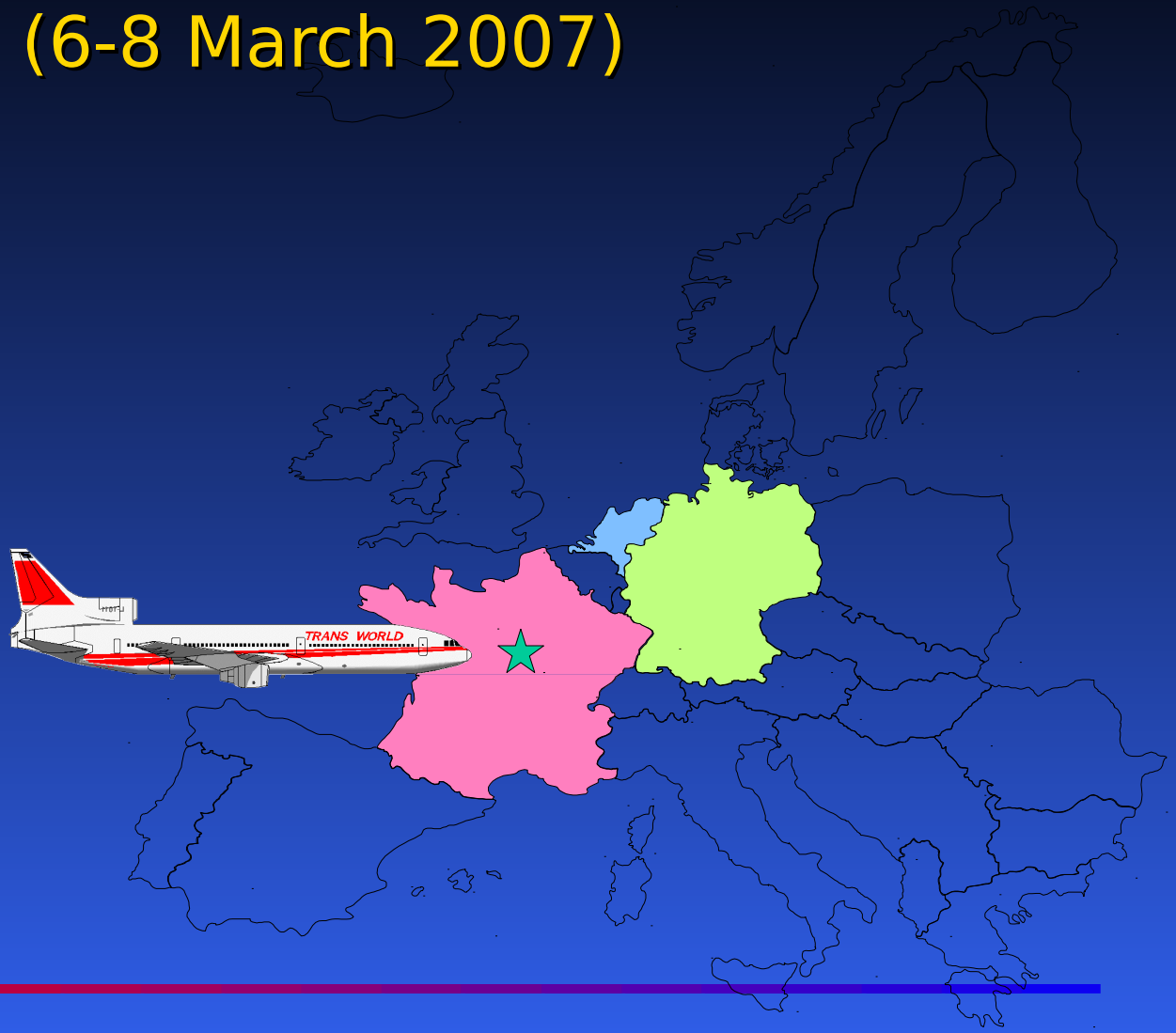
Percentages of European Operator and Operation Type

	LOCKS				BRIDGES			
	Mainly commercial (>70%)	Mixed	Mainly leisure(>70 %)	TOTAL	Mainly commercial (>70%)	Mixed	Mainly leisure(>70 %)	TOTAL
UNPOWERED - HAND OPERATED - USER			67%	56%			12%	5%
UNPOWERED - HAND OPERATED - KEEPER		20%	14%	13%			3%	1%
LOCAL - MANUALLY OPERATED - USER	2%		1%	1%				0%
LOCAL - MANUALLY OPERATED - **KEEPER**	24%	6%	5%	7%			3%	2%
LOCAL - SEMI-AUTOMATIC OPERATION - USER			3%	2%			20%	9%
LOCAL - SEMI-AUTOMATIC OPERATION - **KEEPER**	48%	19%	3%	7%	68%	81%	51%	65%
REMOTE - SEMI-AUTOMATIC OPERATION - **KEEPER**	12%	4%		2%	29%	14%	3%	12%
AUTOMATIC OPERATION - ACTIVE	15%	51%	7%	12%		3%	7%	4%
AUTOMATIC OPERATION - PASSIVE								0%
TOTAL	399	603	5055	6057	352	594	764	1710

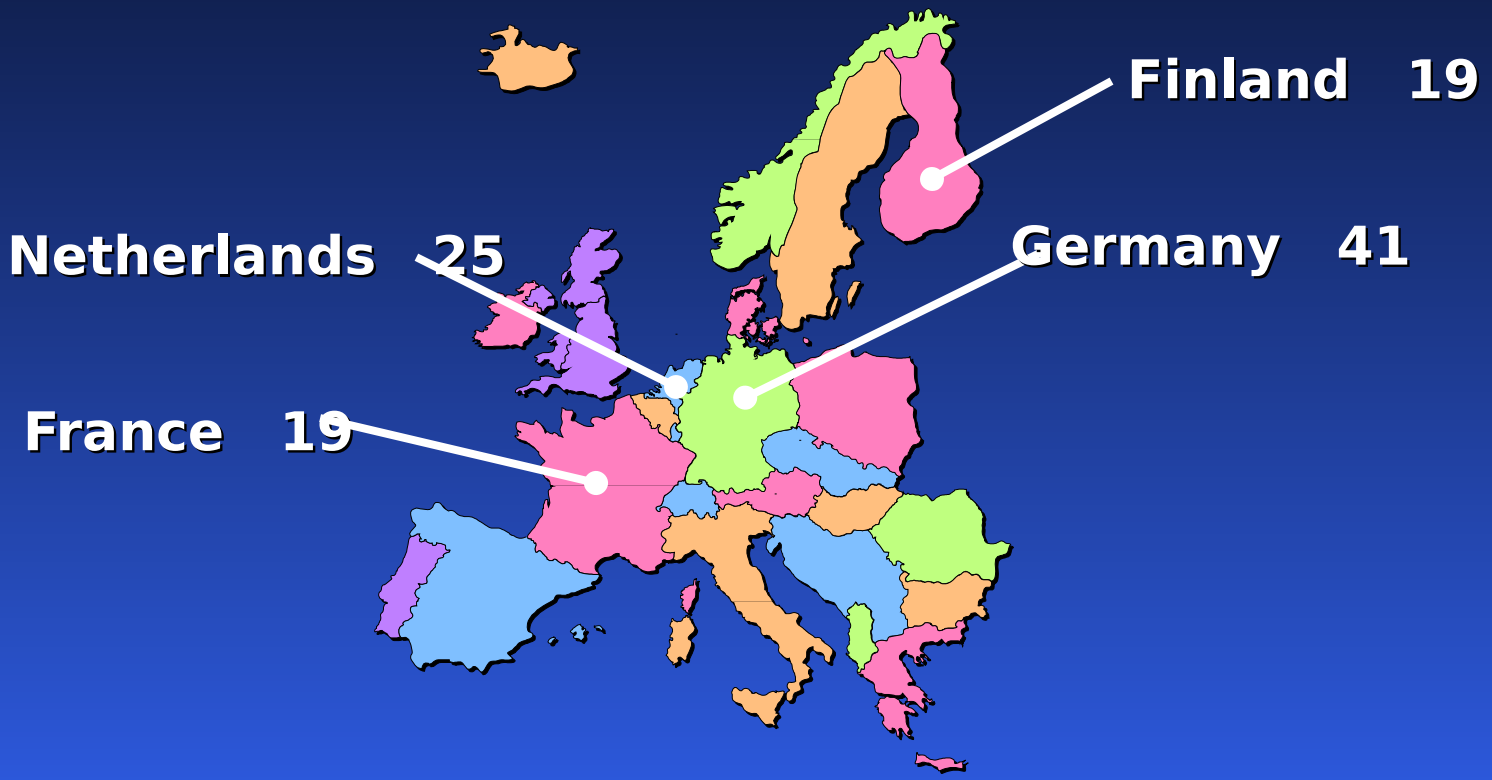
Final Meeting in Paris

(6-8 March 2007)

Arrive in Paris



Remotely Operated Locks on Waterways in Europe



Waterways of Europe

Kietele canal

Remote Control of 5 Locks on Keitele Canal

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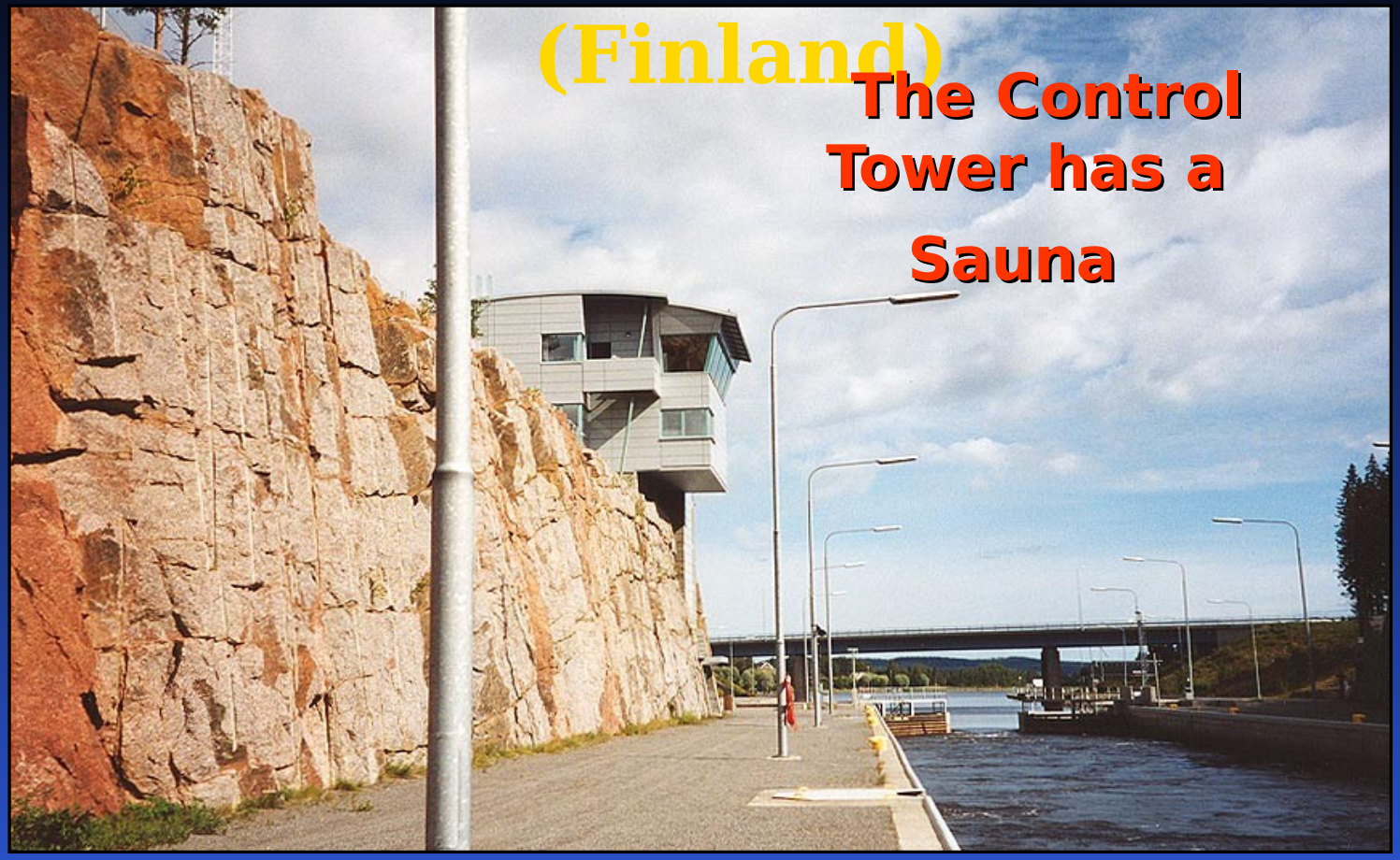
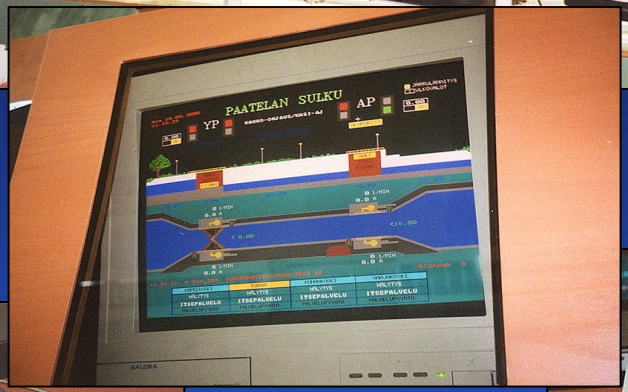
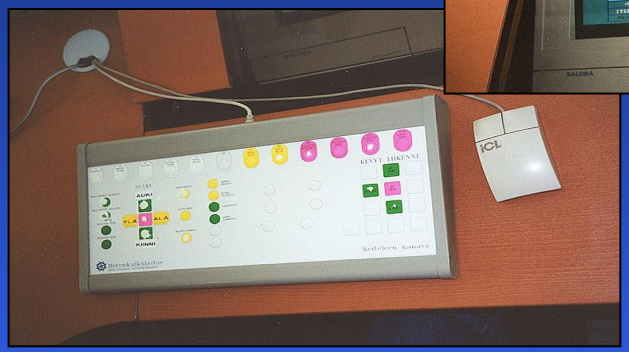
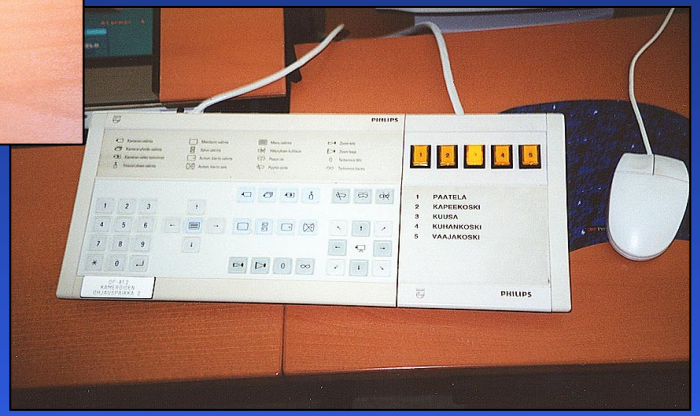
Paatela Lock Control House for Remote Control of 5 Locks (Finland)



Paatela Lock Remote Control Room for 5 Locks







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Netherlands
International boundary
Province boundary
National capital
Province capital
Railroad
Expressway
Road
0 10 20 30 Kilometers
0 10 20 30 Miles
Beatrix Lock
HeumenLock
Heel Lock
North Sea
WEST FRISIAN ISLANDS
Schiermonnikoog
Borkum
Nes
Ameland
Terschelling
Vlieland
Waddenzee
Texel
Den Burg
Den Helder
FRIESLAND
Leeuwarden
Harlingen
GRONINGEN
Groningen
Delfzijl
Emden
Leer
Sneek
Heerenveen
Assen
DRENTHE
Emmen
Hoogeveen
Meppel
Coevorden
IJsselmeer
NOORD-HOLLAND
Alkmaar
Hoorn
Emmeloord
Lelystad
Dronten
FLEVOLAND
OVERIJSSEL
Zwolle
Lingen
Nordhorn
Raalte
Almelo
Deventer
Rheine
Hengelo
Enschede
Apeldoorn
Beverwijk
Zaanstad
Haarlem
Amsterdam
Purmerend
Hilversum
Leiden
The Hague
Hoek van Holland
Delft
ZUID-HOLLAND
Gouda
Utrecht
Zeist
Ede
Arnhem
GELDERLAND
Doetinchem
Europoort (international seaport)
Rotterdam
Vlaardingen
Nijmegen
Kleve
Emmerich
Oss
Dordrecht
HOLLAND
Hertogenbosch
Waalwijk
Breda
Tilburg
Roosendaal
Middelburg
Bergen op Zoom
ZEELAND
Vlissingen
Knokke
Terneuzen
Helmond
Eindhoven
BRABANT
Turnhout
Antwerp
Brugge
Gent
Aalst
Kortrijk
Mouscron
Brussels
Leuven
Halle
Hasselt
Weert
Roermond
LIMBURG
Venlo
Krefeld
Duisburg
Essen
Dortmund
Düsseldorf
Cologne
Sittard
Heerlen
Maastricht
Aachen
Düren
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Liège
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FEDERAL REPUBLIC OF GERMANY
Base 800383 (A01914) 3-87

The Netherlands: Beatrix Lock Control House (Ergonomi

Beatrix Lock Control Tower

Beatrix Lock Control Room

30/03/2007 09:15

GERMANY

Remote Control of Locks

- Main River (Pilot Project, Harrbach Lock) &

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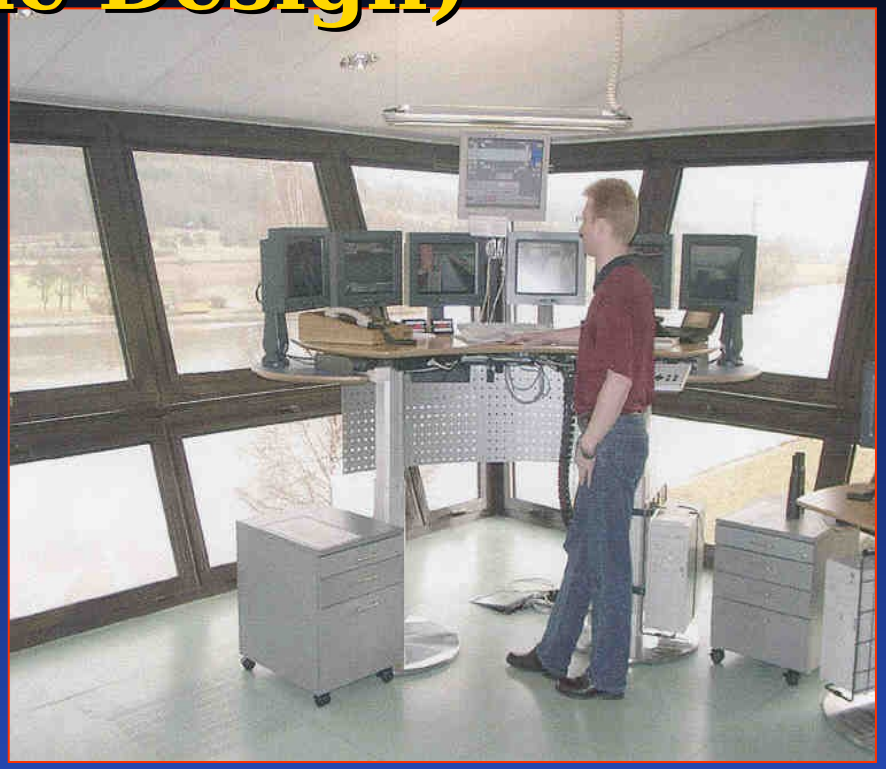
Harrbach Lock Control Room (Ergonomic Design)

Control Table in "Sitting Position"



Control Table in "Standing Position"

Conclusions

- Lock Automation can be used to increase safety, reliability and efficiency in navigation locks
- Lock Automation and Remote Control has been sucessfully used at Paatela Lock in Finland for 10 years without any accident; lock operators reduced from 15 to 2
- Lock Automation and Remote Control has been used at the Heel Lock Complex in The Netherlands since 1985 to control 3 Locks: Heel Lock, Linne Lock and Roermond Lock
- Lock Automation and Remote Control is being used at Harrbach Lock in Germany to control 4 locks, additional locks on the Danube have also used remote operation
- Lock Automation and Remote Control used in France to control 7 Locks on the Saint Denis Canal as well as new small locks

Overall Conclusions (Report)

- Safety is the number one priority.
- Bridges, especially with rail traffic, require more operational and safety consideration than locks due to their greater safety risks.
- Not every structure is suitable for remote operation.
- Comparing the results of the two surveys there seems to be an increase in the number of automated locks demonstrating that it is a successful change.
- Maintenance must be appropriate for the increased sophistication of mechanized or automated systems.
- Mechanization or automation provides new job opportunities for the workforce.
- Waterway operators can learn from the experience of the industrial sector and process industries since they have been using PLC technology for more than 30 years

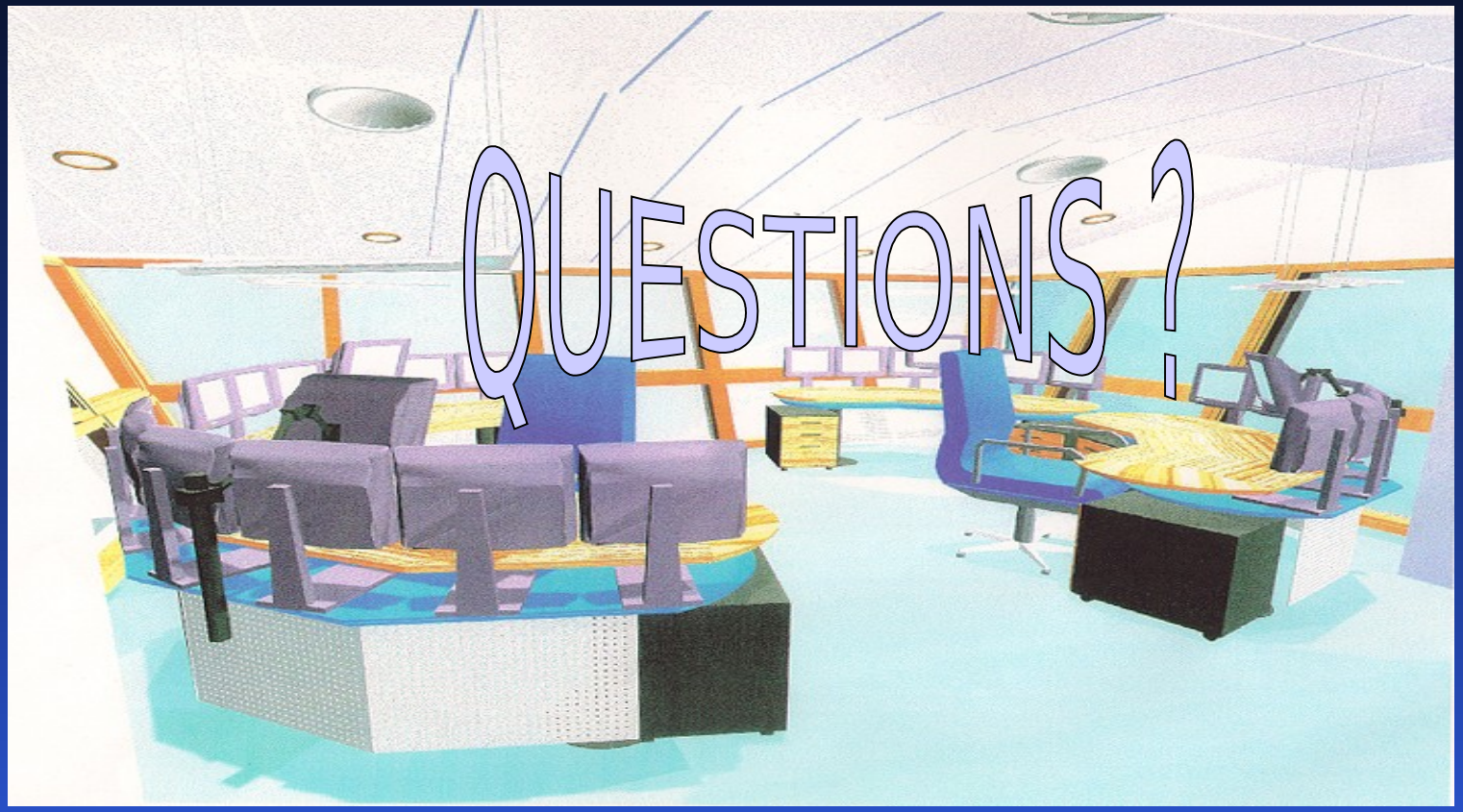
Recommendations (Report)

- Even in a fully automated system, there must be provisions for operating the structure in the event that all the automation fails.
- Proper maintenance is essential.
- Staff should not be overburdened when remotely operating a structure. They should concentrate on one task at a time to ensure smooth operation and user safety.
- Lock operating staff should be integrated at all levels of organization.

Additional Benefits of Lock Automation
Condition Monitoring & Predictive Maintenance

- **The process of employing automated monitoring systems with field devices and sensor technology to predict the necessity of equipment maintenance.**

Hand-held Vibration Monitoring Kit


QUESTIONS ?